Brain changes with macular degeneration

The McGovern Institute for Brain Research at MIT, a leading research and teaching institute committed to advancing understanding of the human mind and communications, announced today that scientists have discovered the first evidence that brain reorganization occurs in people suffering from the progressive visual disorder macular degeneration.

The study, "Reorganization of Visual Processing in Macular Degeneration," was published in the Jan. 19 issue of The Journal of Neuroscience by MIT postdoctoral associate Chris Baker and Professor Nancy Kanwisher, in collaboration with Professor Eli Peli of the Schepens Eye Research Institute at Harvard Medical School.

Macular degeneration is the leading cause of blindness in the developed world, affecting more than 1.7 million people in the United States, and many millions of people worldwide. In macular degeneration, the center of the retina is damaged and sight is limited to peripheral vision. People suffering from this disease have blurry vision, which often causes severe difficulties with everyday tasks such as reading, driving and recognizing people.

"Our major finding is that the part of the brain that processes only central retinal visual information in people with normal sight reorganizes itself in people with macular degeneration to help process peripheral visual information," said Baker.

Using advanced brain imaging techniques and state-of-the-art retinal mapping techniques, the researchers monitored which parts of the brain process visual signals in people with macular degeneration compared to people with normal vision.

"While our findings do not have immediate clinical application, the fact that a larger region of the cortex is recruited for peripheral vision in people with macular degeneration is encouraging, and suggests that it may be possible to develop new rehabilitation strategies that exploit this increased cortical involvement to partially compensate for loss of retinal function," said Kanwisher.

The researchers plan to explore whether the brain reorganization enables people with the disease to see better with peripheral vision than other people, and to identify the conditions that lead to these changes in the brain.

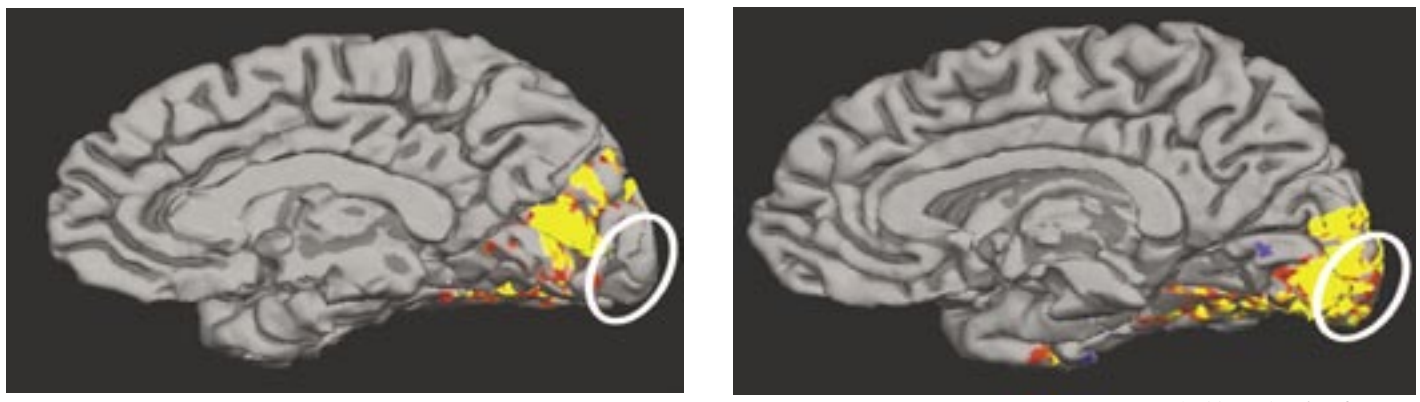


IMAGE COURTESY / **CHRIS BAKER**

These images of human brains, based directly on data from an MRI machine, show the regions of the brain that are activated by peripheral visual stimuli in a person with normal vision (left image) and in a person with macular degeneration (right image). People with macular degeneration lack central vision and must use peripheral vision only. The area at the back of the brain (marked by the white ovals) that normally responds only to stimuli in central vision, was strongly activated in the person with macular degeneration but not in the subject with normal vision. This shows that there has been reorganization of visual processing in the brain with macular degeneration.

Irrigation key to China's food production

Nancy Stauffer
Laboratory for Energy and the Environment

An MIT team has systematically evaluated how water and land limitations affect the production of food in China. Initial findings suggest that China should be able to produce enough food to meet its growing population if it expands irrigation to permit more intensive farming, especially in the northern regions.

The analysis, led by Professor Dennis McLaughlin of the Department of Civil and Environmental Engineering, is a response to growing concern about feeding the world's expanding population.

"Many water-scarcity studies extrapolate recent trends in developing countries and say there is going to be a disaster," said McLaughlin, the H.M. King Bhumipol Professor. "My opinion is that these studies rely more on anecdotal evidence rather than a rigorous hydrologic analysis."

To fill that gap, he and recent graduates Amy Watson (S.M. 2004) and Marine Hermann (S.M. 2004), and graduate student Piyatida Hoisungwan have developed an approach that uses classical hydrologic methods and available data to determine how water scarcity affects a region's ability to produce food.

As a case study, they have been examining China, a country that depends almost entirely on domestically grown food. The study does not consider economic or political factors or food-distribution issues, but simply addresses the question of how many people China can feed with locally available land and water resources.

The researchers formulated a model that divides China into 2000 pixels. Each pixel is several hundred kilometers on a side and has its own distinctive rainfall, climate and land use. Six crop categories can be planted, with seasonal crop rotations allowed.

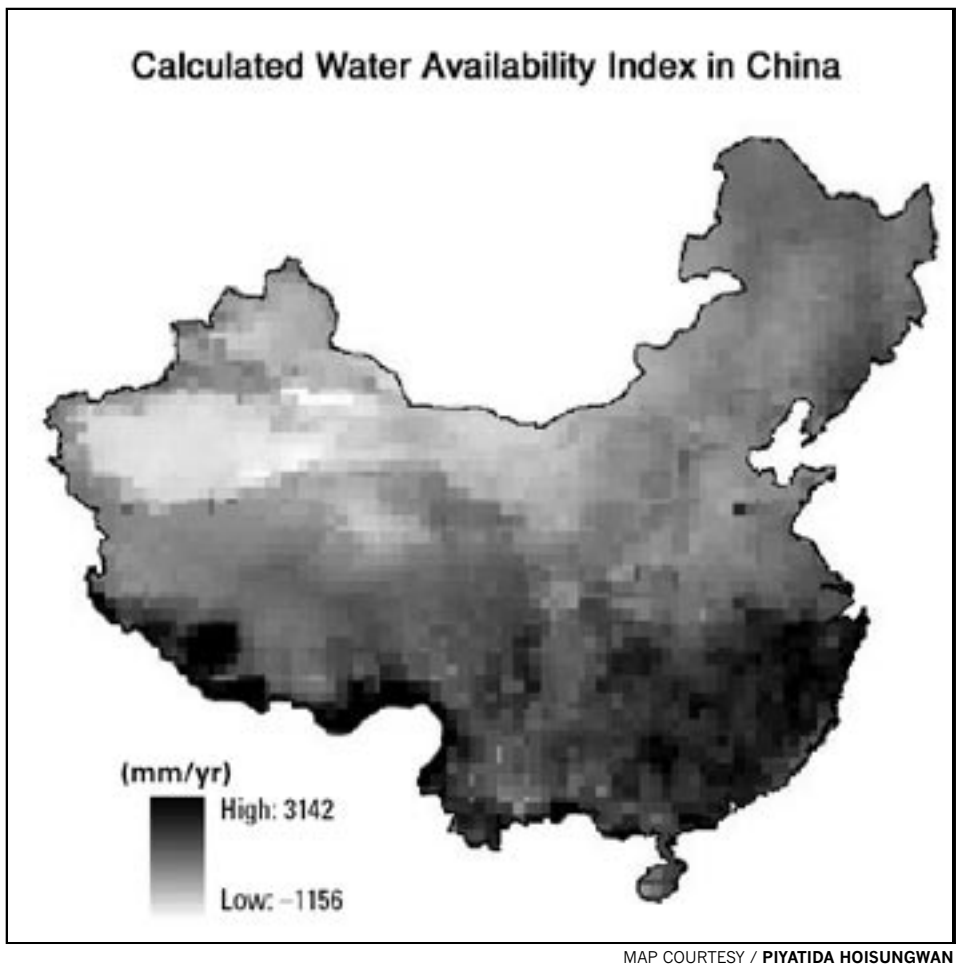
The team then performed two analyses—a "nominal" case and a "sustainable" case. The nominal case assumes current conditions: the total land available for crops is equal to the land now being cultivated, and irrigation occurs at today's level. It also allows people to pump ground water wherever the extra water can be used. Based on those assumptions and available data, the model predicts that China can produce enough food to feed between 1.1 and 1.7 billion people.

The sustainable case also assumes current cropland area, but assumes that all of the land is irrigated, permitting farmers to grow crops more extensively and more frequently. To achieve sustainability, this case excludes groundwater pumping, which depletes underground reservoirs over time. Under those assumptions, the model concludes that China would be able to feed between 1.3 and 2.0 billion people.

The wide ranges of food production estimates produced by the model reflect uncertainty about China's current cropland area, which the team is working to clarify. Until such uncertainties can be reduced, the team is using a mid-range cropland estimate. With that estimate and the sustainable-case assumptions, they found that food production is enough to feed about 1.6 billion people—roughly the population of China predicted by the United Nations for 2030.

Thus, China should have enough water and land to feed its people for the foreseeable future if it builds the irrigation infrastructure assumed in the sustainable case.

"This is not an economic analysis. We're not saying that it's cost effective for China to feed all these people with domestic production," said McLaughlin. "It might be more cost effective for them to invest in new semiconductor plants and use the income to buy food from Canada." This study simply examines one option whereby China can feed its growing population.



MAP COURTESY / **PIYATIDA HOISUNGWAN**

This map shows the spatial variability in China of one key input to farming—water. Water is generally abundant in the south and scarce in the north and west.

Quieter, cleaner airplane landings may be ahead

An experimental procedure that substantially reduces the noise of descending aircraft is one step closer to availability for commercial air carriers, thanks to the continuing efforts of a research team led by Professor John-Paul Clarke of the Department of Aeronautics and Astronautics.

In addition to improving the lives of people living and working along airport approach routes, the new procedure reduces aircraft engine emissions and fuel consumption.

Initial tests in 2002 using two United Parcel Service-provided Boeing 767 aircraft proved that the noise of landing airplanes could be greatly reduced by modifying descent paths and procedures. The researchers have now completed a significantly more complex test, applying their protocol to multiple aircraft in scheduled service. In a two-week trial last September at Louisville Regional Airport involving 126 UPS evening flights, Clarke's team demonstrated that air traffic controllers could handle 12 to 14 flights per night using the procedure. The tests also confirmed the procedure's environmental and economic benefits.

In traditional approaches, aircraft begin descending many miles from the runway, spending substantial time at relatively low altitudes. These paths are analogous to a staircase: planes descend in steps requiring noisy engine thrusts every time they level out.

The new procedure, called a continuous descent approach or CDA, keeps aircraft at cruise altitude until they are relatively close to an airport. At this point, the aircraft make an even, continuous descent to the runway. The result is an average noise reduction of four to six decibels. A three-decibel difference is appreciably noticeable to the human ear while a 10-decibel reduction equates to 50 percent less noise. Side benefits include reduced fuel burn and emissions, and slightly shorter flights, as aircraft operate at lower power settings, stay at higher altitudes, maintain higher speeds, and take more direct—and thus shorter—paths to the runway.

Clarke's team includes other MIT researchers as well as representatives of Boeing, the FAA, the Louisville Regional Airport Authority, NASA and UPS. More work remains before CDA approaches are officially implemented at Louisville, and then elsewhere. They must refine the operational procedures for conditions beyond the two-week test environment. Additional research and testing is required for airports with heavier traffic volume and greater diversity of airlines and aircraft types. Other airports, airlines and the FAA are evaluating CDA for applicability to nighttime operations.

Design and approval of new flight and landing procedures is an extremely complex undertaking. Researchers and authorities must be assured that airborne and ground-based computers, flight crews, air traffic controllers and aircraft are adaptable to the new protocol, both individually and in unison.

"Safety is always everyone's paramount concern," said Clarke. "Now that the process is validated, the same tools can be used to customize similar procedures for other airports."

The Louisville project was funded by Congress. It is one of 10 projects being conducted under the auspices of the Partnership for Air Transportation Noise and Emissions Reduction.